very approximate equivalent in the elaborate illustrations and descriptions. He begins by showing the rigidity of flexible bodies when in motion: he then describes the behaviour of a common top by means of a balanced gyrostat, and explains the importance of giving a rotary motion to projectiles. The gymbal gyroscope and the curious movements that are connected with it are afterwards discussed, and the analogy of these movements to that of the earth in regard to precession, &c., is pointed out.

The next point referred to is the importance of balancing a rotating body, the author showing that for perfect balance not only must the axis of rotation pass through the centre of mass of the body, but it must be one of the three principal axes through the centre of mass of that body. Reference is made to the experiments of Prof. Milne, who has shown, by means of a modified seismograph, the want of balance in the wheels of locomotives.

In the last few pages Prof. Perry deals with the connection between light and magnetism and the behaviour of spinning tops, and among the experiments is Thomson's mechanical illustration of Faraday's rotation of the plane of polarization, which is performed by means of a number of double gyrostats placed in a line and connected by india-rubber joints, each instrument being supported at its centre of gravity, and capable of rotation in the horizontal and vertical planes. To many readers the book will be one of great interest, and a brief summary at the end will show them clearly the line of argument adopted throughout.

Wild Life on a Tidal Water. By P. H. Emerson. (London: Sampson Low, 1890.)

IT seems rather odd that an author should talk about "wild life" when he means simply life on a house boat on Breydon Water in Norfolk. No one, however, who glances over the present volume will be disposed to criticize the title very severely, for Mr. Emerson has the art of describing even unimportant things in a way that makes them interesting. Above all, he has provided a series of thirty admirable "photo-etchings," which convey a wonderfully vivid impression of the various scenes reproduced. The photographic plates were taken by Mr. Emerson himself, but in selection of subject the majority are the result of a pleasant partnership with his friend Mr. T. F. Goodall, on whose house-boat he experienced the trials and delights of "wild life."

Arcana Fairfaxiana. With an Introduction by George Weddell. (Newcastle-on-Tyne: Mawson, Swan, and Morgan, 1890.)

THE manuscript of which a facsimile is presented in this volume was found some years ago by Mr. Weddell in a box of lumber. It contains much apothecaries' lore and housewifery dating from the first half of the seventeenth century, and was used, and partly written, by the Fairfax family. In a carefully-written introduction Mr. Weddell gives all necessary information about his treasure and about the persons with whom it has been associated. The facsimile is skilfully printed, and many of the medical receipts, and some of the instructions as to the baking of meats, are very curious and interesting.

Berge's Complete Natural History. Edited by R. F. Crawford. (London: Dean and Son, 1890.)

IN this volume some of the leading facts relating to the animal, the vegetable, and the mineral kingdoms are brought together. The descriptions, if not very interesting, are clear, and the reader is helped to understand them by means of no fewer than sixteen coloured plates, and over three hundred smaller illustrations.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Bursting of a Pressure-Gauge.

WITH reference to Mr. Smith's letter in your issue of February 5 (p. 318) respecting the bursting of a pressure-gauge, will you allow us to point out a very simple method of preventing any serious consequences from such an accident, which must occasionally occur as the gauges wear out? There should be no cast-iron in the gauge: the tube and works should be mounted on a brass or gun-metal frame. The glass covering the dial should be mounted in a ring, fitting on the body of the gauge like a cap; when the gauge is in use this cap should be removed, thus avoiding all danger from the broken pieces of glass. The gauge should then be inclosed in a brass wire cage, so that, should the tube burst, any portions of metal would be caught by the wire network, and, if not stopped altogether, would at any rate be rendered harmless.

Our *employés* are constantly using gauges for testing gas bottles, and we have always had our gauges made in this way to avoid any risk from accident. The screw valve of the bottle should not be turned on full, one complete revolution of the screw is quite sufficient; this greatly minimizes the risk of fusion caused by friction, as the cylinder would probably take a quarter of an hour to empty itself. Of course the same gauge should never be used for both oxygen and hydrogen cylinders.

3 Fleet Street, February 11. NEWTON AND CO.

Modern Views of Electricity.

(1) THE first question that I raised in my former letter was how oxygen atoms come by the negative electricity which according to Dr. Lodge they have. I find in his pamphlet, "Seat of E.M.F." (p. 50), his view stated as follows, that whatever may be the case with molecules of oxygen, at least all dissociated atoms have a certain definite negative charge. If this be so, it seems to me to follow necessarily either that all molecules of oxygen are negatively charged, or that only those which are so charged can undergo dissociation.

(2) We are then to suppose a crowd of dissociated atoms of oxygen, all having negative electrification, "straining at," *i.e.* attracted by, the zinc. And this attraction, we are told (p. 50), exists independently of actual combination between zinc and oxygen, although it has its origin in the desire for such combination. It is a mechanical force arising from chemical affinity. Such a force would, according to the kinetic theory of gases, increase the density, and therefore the pressure, of oxygen in the neighbourhood of the zinc, causing a repulsive force, in addition, as it seems to me, to the repulsion due to like electrical charges. By this means the state of the gas in the neighbourhood of the isolated zinc would become one of equilibrium. And it may be that the variations of density would take place only within a distance from the zinc too small for our means of measurement. According to the statement (p. 110) of "Modern Views," only the repulsive forces arising from electrification are relied upon as producing equilibrium. I think, however, that Dr. Lodge would not exclude other mutual repulsive forces which may exist between the dissociated atoms of oxygen. And such other forces appear to me to be necessary, in order to explain satisfactorily the phenomena which ensue when the zinc is brought into contact with copper.

(3) When contact is made, a positive charge passes from the copper to the zinc. Let us call it σ per unit of surface. That disturbs the equilibrium previously attained about the zinc, because it introduces a new force of attraction on the oxygen atoms in virtue of their negative electrification. This force will be $2\pi\sigma$ per unit of surface. In order that there may again be equilibrium, we must introduce a counteracting force $-2\pi\sigma$. Now the new attractive force calls in a fresh influx of oxygen atoms, increasing their density, and therefore increasing the negative charges per unit of surface of zinc. If we had no repulsive forces, except those arising from electrification, the charges on these newly imported atoms would, I think, have to be $-\sigma$ per unit of area of the zinc, in order to give the required force $-2\pi\sigma$. This would exactly neutralize the positive charge

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$+\sigma$ derived from the copper, and so would reduce the zinc to its original potential. Under these circumstances statical equilibrium could, as it appears to me, never be attained. But if there exist repulsive forces between dissociated atoms of oxygen other than those due to their negative electrification, we may obtain our repulsive force $-2\pi\sigma$ without introducing so many atoms as that their negative charges, referred to unit of surface of the zinc, shall be $-\sigma$. It may be $-\sigma'$, where σ' is less in absolute value than σ. And so we should, on making contact with copper, obtain a total charge on the zinc $\sigma - \sigma'$ per unit of surface. This is positive. The zinc may then be raised to the same potential with the copper, and at the same time the attractive and repulsive forces on dissociated oxygen atoms near the zinc may be in equilibrium. So it seems to me that, assuming the electrification of oxygen and its attraction by the zinc to be as stated by Dr. Lodge, the theory consistently explains phenomena up to this point, and may explain also the variations due to moisture of the zinc or other conditions.

(4) As regards the "intrinsic step" of potential relied upon by Dr. Lodge to explain the aluminium needle experiment, I cannot so easily follow him. Consider the surface of the isolated zinc, and let C be a point just so distant from it that the potential at C is sensibly unaffected by the presence of the zinc with its negative charges, and those of its attendant oxygen atoms. C is then at zero potential, that of the zinc being $-1 \cdot 8$. Intermediate points are at intermediate potentials. When, on making contact, you introduce the positive electricity from the copper, you raise the potential of the zinc by half a volt. But the potential at C is, *primâ facie* at all events, no more affected by the positive than it was by the original negative electrification of the zinc, and remains zero. You have diminished the "step" by half a volt. As before, intermediate points would have intermediate potentials. In fact, so far as the potential at C is concerned, may we not suppose the newly introduced positive electricity simply to neutralize an equal quantity of the negative electricity previously found on the zinc?

S. H. BURBURY.

ON this head I would say that a point outside the surface-film, beyond the molecular range, is naturally unaffected by the chemical affinities of the surface; but it is by no means therefore uninfluenced by the ordinary dielectric strain of a static charge imparted to the zinc in any adventitious manner. Such a charge alters the potential of the whole neighbourhood, but does not alter the slope of potential existing in the surface-film. Nothing can alter that but a modification of the surface or of the adjacent medium.

Thus I state my position briefly in order that the sole remaining divergence of view between Mr. Burbury and myself may likewise disappear.

OLIVER J. LODGE.

PERHAPS the following slight elaboration of Dr. Lodge's views on the electrical condition of air films in contact with metals will commend itself to Mr. Burbury. It seems to me that by its means the difficulty of realizing the source of the negative charge on the oxygen atoms is to a certain extent got over without thereby forfeiting any of the essential features of the air film theory.

Assuming the truth of this theory, the fact to be explained is that when clean zinc is put into pure oxygen it becomes coated with a film of that substance which is at a higher potential than the zinc by $1 \cdot 8$ volt.

If the film be regarded as a conductor, this step of potential has to be brought about in the first instance by combination of a few zinc atoms with oxygen, so that the film becomes coated with + electricity on both its surfaces; the field set up by this and a corresponding − charge on the surface of the metal underneath representing the $1 \cdot 8$ volt step of potential between the two. It is at this point that the difficulty of the − charge on the oxygen atoms arises, as they have just been assumed to be +; and, also, this other smaller difficulty, that the + and − charges on the opposed film and metal surfaces, corresponding to $1 \cdot 8$ volt and at molecular distance apart, are such that every atom in each surface is charged with a quantity of electricity which is of the same order of magnitude as its electrolytic charge; a fact which necessitates the previous combination of every atom in the zinc surface with oxygen from the film if the ordinary laws of electrolysis are to be assumed; whereas according to the film theory, wholesale oxidation of the metal surface destroys the Volta effect altogether.

If, however, the film be regarded as a non-conductor, both these difficulties vanish.

The molecules which form the film would be gaseous except for the presence of the metal. The latter holds them to itself, and may be looked upon as, in a sense, polarizing them into chains or rows normal to its own surface. Supposing such chains to consist each of what were originally three distinct diatomic gas molecules, A_1A_2, B_1B_2, C_1C_2, with a metal atom M next to A_1, there will be a tendency to combination between A_1 and M, which will slacken the

$$M - A_1 \equiv A_2 - B_1 \equiv B_2 - C_1 \equiv C_2 -$$

bonds between A_1 and A_2, leaving A_2 partially free to hold on to B_1, which again will promote a holding on between B_2 and C_1, so that C_2 is partially uncombined. The bonds between A_2 and B_1, B_2 and C_1, represent in fact the cohesion of the film (or part of it), and are the result simply of the tendency to combination between M and A_1. If this be very great, actual combination may occur, which will set free A_2B_1 and B_2C_1 as gas molecules, leaving C_2 to find another partner. On the other hand, the tendency to combination between M and A_1 may be too small to do more than polarize the molecules, and this is perhaps what occurs with zinc in dry oxygen.

If, now, the essence of combination between zinc and oxygen is that the zinc atom is + and the oxygen −, we may assume, without entering on ultimate problems, that the row of molecules is polarized *electrically* as well as mechanically. $A_1B_1C_1$ all −; and $MA_2B_2C_2$ +; so that the film may be looked on as a dielectric plate, with a coating of metal on one side only, and a + charge on the other. The slope of potential between film and metal (*i.e.* the Volta effect) occurs now, not between their surfaces of contact, but right through the film, the $1 \cdot 8$ volt existing between the *outside* surface of the latter and the metal. No actual chemical combination is necessary to bring it about; and, indeed, any combination at all is prevented by the internal affinities in the film itself just described.

A. P. CHATTOCK.

University College, Bristol.

Pectination.

REFERRING to Mr. E. B. Titchener's letters in NATURE (see December 4, p. 103, and January 15, p. 248), I am able to confirm the view that pectinated claws are used by the birds possessing them for the purpose of scratching themselves.

On December 9 last I shot a cormorant, and found the fissures between the teeth of one of its pectinated claws choked up with fragments of down. This down corresponds with the bird's own down, and there can be little doubt that it is the bird's own down, and that it became thus situated through the claw being used for the above-mentioned purpose. I may also mention that I have since found minute fragments of feather in the claw of a barn owl.

Many birds use the middle claw to scratch themselves with, as Mr. Titchener remarks; and this claw appears to be very generally modified for the purpose. The modification consists in this, that the inner edge of the claw is bent out, and developed into a curved blade running along the inner side of the claw. Such a blade is well developed in guillemots and razorbills. It may also be easily seen in wild duck, teal, gulls (some at any rate), oyster catchers, golden plover, starlings, fieldfares, redwings, larks, and many others. In some birds the modification is very slight, but in all I have been able to examine (not an extensive collection) it seems to exist in some degree. In the divers, the claws are so flattened that the inner edge naturally forms a scraper, and the same may be said of other birds, such as partridges and pheasants.

Pectination is only a further modification of this blade, or inner edge of the claw, in that it becomes divided up by notches or fissures, placed at more or less regular intervals, into a comb-like structure. As is known, the middle claw is not pectinated in young nightjars. I have now in my possession a young, though almost full-grown male of this bird, and it has the middle claw provided with a well-developed blade, but there is no trace of pectination. I may mention too, that I have found the edge of the blade in a guillemot, slightly indented here and there, thus offering an approach, though but a very distant one, towards pectination.

The pectinated claw, then, should not be regarded as a structure

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